

# A Comparison of the Incidence of Cricothyrotomy in the Deployed Setting to the Emergency Department at a Level 1 Military Trauma Center: A Descriptive Analysis

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**ABSTRACT** Airway management is a critical skill of emergency medicine physicians and prehospital providers. Airway compromise is the cause of 1.8% of battlefield deaths. Cricothyrotomy is a critical, lifesaving procedure. In this study, we conducted a retrospective descriptive analysis comparing the incidence of cricothyrotomies in the deployed setting versus the incidence in a military level 1 trauma center emergency department (ED) setting in San Antonio, Texas. The deployed/in-theater procedures were performed from September 2007 to July 2009. The ED procedures were performed from April 2010 to February 2012. Over these study periods, 28 cricothyrotomies were performed in the deployed setting against a backdrop of 11,492 trauma admissions compared to 4 cricothyrotomies performed during 2,741 trauma admissions in the ED setting. The per admission incidence of deployed cricothyrotomies was 0.24% versus an incidence of 0.15% in the ED ( $p = 0.46$ ). We conclude that this rare, lifesaving procedure is performed more often in the deployed setting than the ED, but this difference was not statistically significant.

## INTRODUCTION

### Background

Airway management is critical to the stabilization and resuscitation of the seriously ill or injured patient. Definitive airway management in the emergency setting is most commonly accomplished by endotracheal intubation. When endotracheal intubation fails or is not possible because of traumatic injury to the face, neck, or upper airway, a surgical airway, usually cricothyrotomy, is indicated. Failure rates in civilian emergency departments (EDs) for rapid sequence intubation are approximately 1%. Rescue cricothyrotomy was performed in 0.7% of airway management attempts in one series.<sup>1-5</sup> The success of cricothyrotomy ranges between 89% and 100%.<sup>6-8</sup> Surgical cricothyrotomy rates in the deployed military setting are double those in civilian trauma.<sup>9</sup> The ability to perform a cricothyrotomy is an essential and lifesaving skill in altered and failed airways.

### Importance

Injury patterns seen in the deployed setting are often significantly different than in the civilian setting. For example, improvised explosive devices are almost completely isolated to the deployed setting. A recent study on battlefield casualty patterns found that 1.8% of deaths were because of airway injury.<sup>10</sup> Because of the elevated utilization of airway management procedures (e.g., cricothyrotomy) and potential for decreased mortality, advanced training in surgical airways and maintenance of these skills are of particular interest in military medicine. Currently, limited training is available in this procedure for Army physicians at the Tactical Combat Medical Care (TCMC). TCMC is a short course attended by all advanced providers (both physicians and physician assistants) who will be deployed to forward treatment facilities. The TCMC represents the primary source of surgical airway training received by most providers.

### Objective

Our aim was to compare the incidence and outcome of cricothyrotomies at military's only level 1 trauma center to cricothyrotomies performed in the military settings of Iraq and Afghanistan by physicians and physician assistants.

## METHODS

### Study Design and Setting

We conducted a retrospective, comparative, descriptive analysis. Data were extracted from two settings and compared. The primary data were obtained through ED visits at the San Antonio Military Medical Center (SAMMC), San Antonio, Texas, from April 2010 to February 2012. The source of the comparative data was the Department of Defense Trauma

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Registry (DoDTR) during the period from September 2007 to July 2009. The DoDTR serves as a database of trauma patient care across all phases of in-theater setting.

SAMMC, the Department of Defense's only level 1 trauma center, is one of two level 1 trauma centers in San Antonio, and also operates as a regional trauma receiving facility. It serves a population of 1.3 million people. The SAMMC ED has approximately 75,000 patient visits per year consisting of approximately 30% civilian patients, many of whom are nonbeneficiary public trauma. Active duty service members make up approximately 25% of all SAMMC ED visits. The deployed settings included any Role 1, Role 2, Forward Operating Base (FOB), or Battalion Aid Station (BAS) without surgical or anesthesia capabilities.

### Selection of Patients

Potential surgical airway procedures performed at SAMMC were identified by searching by Current Procedural Terminology for emergent tracheostomy (31,603) and cricothyrotomy (31,605) based on the procedures billed. Potential cases were then individually reviewed by one of the authors (M.A.B.) for inclusion eligibility. Included in the study were any cases involving a surgical airway procedure that was performed in the ED during this period, whereas any case that was performed semi-electively, prescheduled, or outside of the ED was excluded. A 22-month time period was selected for inclusion in the DoDTR data set. This time period was chosen based on the most reliable data available after the closure of the SAMMC south campus ED (Wilford Hall Medical Center).

Potential cases from the DoDTR were identified by a data set extracted by author R.L.M. for a separate, previously published study.<sup>9</sup> The DoDTR has been established for the tracking of patient care in the deployed setting. Patient records are created by the providers in the deployed setting and include the Tactical Combat Casualty Care casualty card. Data are then coded for query and analysis. All data from the DoDTR are maintained and stored by the Joint Trauma System Center of Excellence in San Antonio, Texas. The data set used was based on all surgical airway procedures identified in the presurgical facility (pre-SF) setting. The pre-SF setting was identified as any procedure performed in the field, at an FOB or BAS before reaching the receiving SF. In contrast to an SF, an FOB and a BAS lack said surgical services. Procedures performed in the field were only included if they were most likely performed by a physician or physician's assistant (advanced provider), as evidenced by the use of rapid sequence induction (RSI), including paralytic and induction agent medications. The use of RSI medications is limited almost exclusively to advanced providers. Cricothyrotomies performed by medics were excluded, as the scope of this study was to compare the experience of advanced providers in the deployed setting versus a military ED in the United States. Data from this set were reviewed and extracted by one of the authors (S.G.S.).

### Outcome Measurement

The primary outcome is a comparison of the incidence of advanced provider-performed surgical airway between the deployed combat setting and a CONUS military ED.

### RESULTS

During the time period when data were gathered from ED patients in the United States, there were nine total procedures performed, four of which met inclusion criteria. The rest were excluded because they were performed outside the ED or electively scheduled. During this time period, there were a total of 7,528 trauma "activations," of which 2,741 were admitted to the hospital. This yielded a per-admission surgical airway incidence of 0.15%.

During the comparative 22-month time period in the deployed setting, there were a total of 11,492 trauma admissions. This included 73 possible cases, of which 28 procedures met inclusion criteria. Thus, the per-admission surgical airway incidence in the deployed setting was 0.24%. Table I outlines a comparison of the primary outcome data between the deployed setting and ED setting. Table II compares the incidence data reported in this study to previous reports of surgical airways at civilian trauma centers. Table III outlines the differences in baseline demographics between the two settings. In the ED setting, most of the surgical airway procedures occurred in the setting of blunt trauma. Comparatively, most of the procedures in the deployed setting were involved penetrating and blast trauma. The majority of clinical indications in the ED setting were because of "can't intubate, can't ventilate." In the deployed setting, however, the indications were more evenly divided between "can't intubate, can't ventilate" and disruption of head/neck anatomy.

Of the four procedures performed in the ED setting, three patients survived to hospital discharge. Of the 28 procedures performed in the deployed setting, 13 patients survived to hospital discharge. Table IV compares the survival rates of both settings with previously reported survival rates.

### DISCUSSION

This study sought to compare the incidence of cricothyrotomies in a deployed setting compared to that in a military hospital ED in the United States. To the best of our knowledge, this is the first study to compare the incidence of this specific

**TABLE I.** Comparison of the Incidence Between the two Locations

|   | SAMMC          | DoDTR  |
|---|----------------|--------|
| Total Cricothyrotomies                          | 4 <sup>a</sup> | 28     |
| Total Trauma Patients <sup>b</sup>              | 2,741          | 11,492 |
| Percentage of Patients Receiving Cricothyrotomy | 0.15           | 0.24   |

SAMMC, San Antonio Military Medical Center; DoDTR, Department of Defense Trauma Registry. <sup>a</sup>Of these four, two were performed by surgeons and two were performed by Emergency Medicine resident physicians. <sup>b</sup>This includes only trauma patients that were admitted to the hospital. Patients discharged are not included.

**TABLE II.** Comparison of the Incidence Data Reported in This Study to Previous Reports of Surgical Airways at Civilian Trauma Centers

|           | SAMMC           | DoDTR             | Salvino et al <sup>12</sup> | Wright et al <sup>11</sup> |
|-----------|-----------------|-------------------|-----------------------------|----------------------------|
| Incidence | 0.15% (4/2,741) | 0.24% (28/11,492) | 0.36% (30/8,320)            | 0.28% (46/16,669)          |

SAMMC, San Antonio Military Medical Center; DoDTR, Department of Defense Trauma Registry. Note that in Salvino et al, 20 procedures were performed in the ED; 10 were performed in the prehospital setting.  $p = 0.46$  (statistical significance of difference between SAMMC and DoDTR).

**TABLE III.** Differences in Baseline Demographics Between the 2 Settings During the Selected Time Period

|   | SAMMC      | DoDTR <sup>a</sup> |
|---|------------|--------------------|
| Age (Range)   | 49 (36–56) | 27 (7–50)          |
| Male Gender   | 100%       | 96%                |
| Penetrating Trauma  | 1          | 11                 |
| Blunt Trauma  | 3          | 5                  |
| Blast Trauma  | 0          | 10                 |
| Burn Trauma   | 0          | 2                  |
| Percentage of Procedures to Head/Neck Trauma                          | 1/4 (25%)  | 15/28 (54%)        |
| Percentage of Procedures because of “Can’t Incubate, Can’t Ventilate” | 3/4 (75%)  | 13/28 (46%)        |

<sup>a</sup>Seven patients were adults of unknown age. SAMMC, San Antonio Military Medical Center; DoDTR, Department of Defense Trauma Registry.

procedure between the two major locations in which military physicians practice.

Our study demonstrated an incidence of emergent cricothyrotomy in trauma patients in an ED setting of 0.15%. This compares to the incidence in the deployed setting of 0.24%. Although this is almost double the experience at the ED setting, this difference is not significantly different.

Other studies have reported an incidence of 0.28% to 0.36% based on total trauma admissions.<sup>11,12</sup> Studies performed in the prehospital setting have reported an incidence ranging from 0.32% to 0.36%.<sup>13,14</sup> Rates in the ED data set are lower than other reported rates. However, it is worth noting that these previous reports are not recent and many technological changes in airway management have occurred during the gap that may contribute to the differences seen.<sup>15</sup>

There were several pieces of data that were unexpected. First, the incidence of cricothyrotomies in the deployed setting of procedures performed by advanced providers was higher than expected. This is likely multifactorial. Advanced provider treatment locations in the presurgical setting are typically staffed by providers with a variety of training backgrounds. Emergency Medicine (EM)-trained physicians make

up the minority of such providers and few, if any, have significant airway management training. This procedure is usually rarely performed in the ED in the United States.

One hospital demonstrated a decrease in the incidence rate of cricothyrotomy from 1.8% before implementation of an EM residency training program to 0.2% after implementation.<sup>16</sup> Thus, it would be reasonable to presume that advanced training in airway management has an inverse effect on the number of cricothyrotomies performed. U.S. Army advanced providers filling EM resident positions get very brief airway management training during the 5-day TCMC course. However, a significant proportion of these providers have no “real-life” airway management experience before deployment. This may contribute to the higher incidence of surgical airway seen in the deployed setting compared to the ED setting.

The survival rate of patients receiving surgical airways in either the deployed setting or the military ED setting is comparable to other previously reported survival rates. There appears to be a substantially higher survival rate at SAMMC, but this is difficult to interpret given the low total number of procedures performed during this time period and is not statistically significant.

The data primarily highlight the paucity of surgical airways being performed by EM-trained physicians at an ED in a military level 1 trauma center. Of the four total procedures performed, only two were performed by an EM physician. The other two were performed by surgeons (initial intubation attempts were made by ED and anesthesia staff). Given that surgeons are not tasked to fill pre-SFs, their performance of this procedure does not apply to discussion of training providers that will fill those positions. Moreover, the number of surgical airways performed by EM physicians across the United States has been declining.<sup>7,16,17</sup> The rarity of this procedure could be due to a multitude of reasons. First, endotracheal intubation is considered a core skill in EM and RSI has become ubiquitous with EM residency training leading to greater skill with difficult airways and a lower likelihood of a failed airway.<sup>18</sup> Second, airway management

**TABLE IV.** Comparison of Survival to Discharge Rates in Both Study Settings With Previously Reported Comparable Data. With the Exception of Spaite et al and Nugent et al, Other Data Sets are ED-based Procedures

|                       | SAMMC<br>(CONUS ED) | DoDTR<br>(Deployed Setting) | McGill et al <sup>6</sup><br>(ED) | Salvino et al <sup>12</sup><br>(ED/EMS) | Wright et al <sup>11</sup><br>(ED) | Spaite et al <sup>19</sup><br>(EMS) | Nugent et al <sup>20</sup><br>(EMS) |
|-----------------------|---------------------|-----------------------------|-----------------------------------|---|------------------------------------|-------------------------------------|-------------------------------------|
| Survival to Discharge | 75% (3/4)           | 46% (13/28)                 | 32% (12/38)                       | 50% (15/30*)                            | 33% (15/46)                        | 15% (3/20)                          | 27% (15/55)                         |

ED, Emergency Department; EMS, Emergency Medical Services; SAMMC, San Antonio Military Medical Center; DoDTR, Department of Defense Trauma Registry. Note that in Salvino et al, 20 procedures were performed in the ED; 10 were performed in the prehospital setting. \*This number includes cricothyrotomies performed in the ED and prehospital by EMS.

techniques have changed significantly in the past decade.<sup>15</sup> Specifically, video laryngoscopy has become widely available, which has likely eliminated some of the issues that had made direct laryngoscopy challenging (e.g., maintaining cervical spine immobilization).

Our data set demonstrates that this procedure is rare at our level 1 trauma center ED, compared to the deployed setting. The exact reasons for this cannot be clearly discerned from our data set, and is likely multifactorial. Two potential reasons are that many of these positions are being filled with physicians with little airway experience, combined with a lack of the technological advances being available in both settings. It is reasonable to presume that standard airway management techniques were at least attempted by the forward provider given the use of RSI medications. However, the exact nature of the attempted airway algorithm is not available. Further research is needed to determine which aspect of training may be lacking before any definitive conclusions can be drawn. Until such data are available, additional airway training to include standard techniques and surgical management need to be continued. Availability of necessary airway tools and adjuncts must also be considered when providers are deploying. The availability of RSI medications to providers with limited airway training must also be considered when both of the above mentioned issues are present. Considerations for access to RSI medications must be based on access to equipment and experience. RSI medications have the ability to take a patient that is breathing and put them into a state of complete apnea.

## LIMITATIONS

The data from SAMMC are limited by the search methods and data extraction. We searched by Current Procedural Terminology code, which requires that the procedure was properly coded. However, all the authors were working at SAMMC full time during the time period, which would reduce the likelihood of a procedure being missed. One single investigator (M.A.B.) conducted all data extractions, which limited any associated variances.

The data from the DoDTR were limited by both the search and data extraction. Given the nature of a combat environment, detailed charting is not always available. This could have resulted in underestimation of the incidence, which was still significantly higher than the SAMMC data set. Anecdotally, EM staff at SAMMC who have worked at a deployed SF noted that cricothyrotomies are not infrequent, confirming a likely underestimation. Additionally, limited charting limits the data that can be extracted from each chart. R.L.M. extracted all DoDTR data with any associated variances.

Another limitation to this study is that the patterns of injury in the deployed setting are different from the ED setting in the United States, particularly, as blast injuries are virtually nonexistent in the civilian setting. These different injury patterns cause inherent difficulties in comparing data

sets, and any potential differences could be because of differences in injury patterns.

## CONCLUSIONS

Cricothyrotomy is a rare procedure, performed at a similar rate in the deployed combat setting and a military ED at a level 1 trauma center. Survival rates are also not statistically significantly different, and consistent with prior published studies.

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